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Excess Rainfall in Relation to T-200 Dates for Contrasting Sites in the West Midlands

by I A Barrie

Summary

An analysis of excess winter rainfall and temperature records from Newport, Shropshire (altitude 64 m; AAR* 660 mm) and Buxton, Derbyshire (307 m; 1284 mm) show that only small totals of excess rainfall may be expected after the date of the T-200 temperature accumulation has been reached at the lower site. In wetter, upland areas the greater amount of excess rainfall could cause leaching through some soil types.

On comparable lowland sites, therefore, leaching losses of nitrates from grassland will be negligible if the T-200 guidelines have been adhered to. On upland sites not liable to leaching the utilisation of early grass for grazing or conservation will be a greater problem.

Introduction

The weather during the first months of 1983 highlighted some of the problems associated with early applications of nitrogen top-dressing onto grassland.

The weather patterns were notable in two major respects. Firstly came one of the mildest Januarys since 1921 (Manley 1974), during which there was a little unseasonal grass growth only to be followed by a prolonged spell of cold dry weather in February. Secondly came the very wet months of April and May which produced rainfall totals each around twice the monthly average.

The difficulties caused by the weather to grazing and conservation at climatically different sites are put into an historical context.

* AAR: Average Annual Rainfall, 1941-70.

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Timing of Nitrogen Application

The T-200 concept of using "thermal time" to help optimise the yield of early grass has been widely discussed in both the popular and scientific literature (Daley and Mackenzie 1983 Whinham and Russell, 1982). Comparisons have been made between several different methods for deducing the optimum date for spring nitrogen applications (Harkness, 1983). The concensus of opinion is that in the large majority of years the T-200 method will produce a yield of at least 90% of the optimum.

An analysis of twenty-five years of temperature records from Newport and Buxton determined the average dates of the T-200 values, and the variation around that date:

Table 1

Median and extreme T-200 dates, 1959-83

	Median T-200 date	Quartile Range	Earliest date	Latest date
Newport	23 Feb	11 Feb-27 Feb	1 Feb 1983	31 March 1963
Buxton	10 Mar	28 Feb-18 Mar	14 Feb 1975	16 April 1979

These values are in broad agreement with those given by Roy et al (1980) and suggest a lapse rate with height of around 9 days per 100 m. This lapse rate is not constant and more detailed information is given by Sparks (1983).

Excess Rainfall

This term is used to define the combined effects of drainage and run off of rainfall falling on a soil which is considered to be at field capacity. The values given here are taken from the MORECS computer model (Thompson et al, 1981) which was run for the two sites over the years 1971-80 (Table 2 a/b).

It has been shown in many experiments (Burns et al, 1982; Kolenbrander, 1969) that excess rainfall and the leaching of fertilisers (principally nitrate) in arable soils are closely related. With a knowledge of crop cover, soil type and excess rainfall an estimate of leaching losses can be made. Leaching under arable crops will be greater than under grassland but for simplicity only the latter is considered here.

Long term averages for field capacity conditions and the winter total of excess rainfall are given by Smith and Trafford (1976): see Table 3.

Table 3

Median dates for field capacity and excess winter rainfall (mm) 1941-70

	Return to Capacity	Quartile Range	End of Capacity	Quartile Range	Excess Rainfall (winter)†	Quartile Range	AAR (mm)
Area 19 (Newport)	19 Nov	20 Oct-18 Dec	13 Apr	24 Mar-4 May	201	121-274	660
Area 10 (Buxton)	14 Aug	*-7 Sep	19 May	29 Apr-*	795	648-904	1284

AAR = annual average rainfall. * indefinable: †total to 31 March.

During the period 1971-80 the average values for the return to capacity and excess rainfall averages from the MORECS model are as follows.

	Return to Capacity	Excess Rainfall (mm)
Newport	25 Nov	211
Buxton	15 Aug	701

These indicate that the 10 year period chosen for this analysis is representative of the longer term.

Excess Rainfall after the T-200 Date

Of main interest in this analysis is the amount of excess rain which occurs after the T-200 level has been attained. Any rainfall prior to this date is considered to have drained away.

The monthly totals of excess rainfall shown in Table 2 a/b are split to show the amounts before and after the T-200 date each year, but in order to reflect the wetter colder climate of the upland site excess rainfall up to the end of May is given. The excess rainfall at Newport during April and May is negligible in most years, while that at Buxton often exceeds 100 mm. The annual totals of E.R. occurring between the T-200 date and the end of May are given in Table 4.

Table 4

Excess Rainfall from the T-200 Date to 31 May (mm)

	Newport		Buxton	
Year	T-200 Date	E.R.	T-200 Date	E.R.
1972	25 Feb	41	15 Mar	236
1973	11 Feb	38	19 Feb	94
1974	8 Feb	58	15 Feb	59
1975	1 Feb	67	14 Feb	162
1976	9 Feb	38	25 Feb	94
1977	23 Feb	32	10 Mar	167
1978	2 Mar	20	13 Mar	104
1979	28 Mar	39	16 Apr	114
1980	22 Feb	76	8 Mar	87
	Median	39 mm		104 mm

The implications of these amounts of E.R. in terms of leaching losses may be gauged from the work of Kolenbrander (1969), Shaw and Jones (1976) and Dowdell (1982). Under widely differing rainfall regimes and over periods of several years the amount of nitrate leachates during early springtime on even light but well structured soils (Newport and Rheidol series) were found to be close to zero.

These results suggest that early top dressings of nitrogen may be applied onto well structured soils without much danger of a significant proportion being subsequently leached. On thin, cracking or poorly structured soils the amount of excess rainfall necessary to diffuse the nitrate through the soil profile, or to an impermeable clay layer will be correspondingly less. The soils in Derbyshire which are at greatest risk are listed in Annexe 1 (R C Palmer, personal communication). In addition to the greater risk of leaching in upland areas there is the further problem of utilisation of grassland early in the season.

Utilisation of Early Grass

Heavy or prolonged rainfall during late spring or early summer will delay any build-up of a soil moisture deficit. To graze or work on the land while the soil is still fully wetted will result in poaching or soil compaction. Conditions experienced during 1983 were particularly poor in this respect (see Annexe 2). Levels of soil moisture deficit below which the land is best left undisturbed will vary according to the soil type, but a level of 5 mm may be taken as a guide. Table 5 shows the number of days for each spring month during which the soil moisture deficit was 5 mm or less (MORECS data).

Table 5

Number of Days between March and May with an SMD $\leq$ 5 mm

	Newport			Buxton		
	March	April	May	March	April	May
1971	31	6	4	31	8	4
1972	17	14	0	28	19	20
1973	14	2	0	13	14	13
1974	27	0	0	27	0	0
1975	28	24	0	30	24	3
1976	19	0	0	24	18	15
1977	28	7	9	31	29	14
1978	25	15	7	31	19	0
1979	31	14	7	31	24	27
1980	31	4	0	31	4	0

Clearly at a lowland site the soil will often be at or close to field capacity until mid to late April and similarly around mid to late May at upland sites.

Conclusions

From the climate data presented, the large differences between conditions on lowland and upland sites is apparent. Excess rainfall amounts after the T-200 date has been reached are normally small in low-lying areas where stocking is often intensive and early grass growth important. Leaching losses of nitrate would be negligible on all but the poorest soils. On upland sites where the need to replace dwindling stocks of winter feed makes early grass growth very important, the greater amounts of excess rainfall increase the likelihood of leaching on thin, cracking or poorly structured soils especially.

Leaching through a well structured deep soil is likely to be small as the nitrates will be evenly diffused down through the soil profile. The greater problem here is in utilising the grass. However, selected drier fields may be utilised for grazing and others used for conservation. The importance of soil conditions around the date of the T-200 sum should be carefully noted as being a factor of greater importance than the calculated optimum date for an early top-dressing.

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Annexe 1

Soil Series liable to experience leaching in Derbyshire

Soil Series	Texture
Bardsey	Clay loam over clay.
Onecote	Peat over impermeable clay.
Wilcocks	Peat over impermeable clay loam.
Crwbin	Shallow silty clay loam over limestone.

Annexe 2

Excess Rainfall during Spring, 1983

The heavy and prolonged rainfall during April and May prevented the establishment of a soil moisture deficit until the first week in June. Grassland utilisation up to that time was virtually impossible in both the Buxton area and much more unusually in the Newport area. Excess rainfall values after the date of the T-200 sum was reached were also well above average: table A.

Table A Excess Rainfall after the T-200 date 1983

	T-200 date	Excess Rainfall (mm)				
		Feb	Mar	Apr	May	Total
Newport	1 Feb	4	16	43	10	73
Buxton	7 Mar	-	98	97	53	248

Table 2a

Excess Winter Rainfall in Relation to the T-200 Date - Newport

	Return to Capacity	Cap - 31 Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total to 31/3	T-200 Date
1971/72	12/8	21	0	21	62	21	107	40/1	30	10	0	303	25 Feb
1972/73	1/12	0	0	0	0	75	21	1/28	10	0	0	135	11 Feb
1973/74	18/7	58	0	12	32	32	70	17/30	28	0	0	322	8 Feb
1974/75	20/11	0	0	0	23	29	51	0/17	13	37	0	133	1 Feb
1975/76	12/2/76	0	0	0	0	0	0	0/14	24	0	0	38	9 Feb
1976/77	4/10	0	0	59	32	47	69	78/17	9	0	6	311	23 Feb
1977/78	17/12	0	0	0	0	16	60	44	1/4	4	12	125	2 Mar
1978/79	14/12	0	0	0	0	62	63	25	61/0	23	16	211	28 Mar
1979/80	11/12	0	0	0	0	65	50	70/19	56	1	0	260	22 Feb
1980/81	6/10	0	0	50	46	43	-	-	-	-	-		-
	Median 25 Nov											median 211	median 22 Feb

Table 2b

Excess Winter Rainfall in Relation to the T-200 Date - Buxton

	Return to Capacity	Cap - 31 Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total to 31/3	T-200 Date
1971/72	13/8	19	0	54	136	31	133	85	47/95	86	55	600	15 Mar
1972/73	31/7	51	0	0	150	103	69	59/17	28	27	22	477	19 Feb
1973/74	15/7	86	12	77	70	150	132	115/10	49	0	0	701	15 Feb
1974/75	4/7	44	129	127	143	127	168	15/17	60	56	29	830	14 Feb
1975/76	14/11	0	0	0	53	113	167	63/0	47	18	29	443	25 Feb
1976/77	3/10	0	0	138	61	99	138	253	5/69	63	35	763	10 Mar
1977/78	1/11	0	0	0	195	108	186	97	12/97	7	0	695	13 Mar
1978/79	4/7	39	82	35	96	179	95	62	183	43/5	109	771	16 Apr
1979/80	16/8	17	11	50	161	191	111	145	7/87	0	0	780	8 Mar
1980/81	14/8	23	43	214	158	120	-	-	-	-	-	-	10 Mar
median values	15/8											701	10 Mar (1959-83)